IN THE UNITED STATES PATENT OFFICE

In Re Patent Application of:)
)   Examiner: Lun LAO
      Gregory C. Burnett, et al.   )   Art Unit: 2614
)

Application No.: 10/667,207   )

Filed: September 18, 2003   )

)

For: VOICE ACTIVITY DETECTOR (VAD)-BASED)
        MULTIPLE-MICROPHONE ACOUSTIC NOISE)
        SUPPRESSION   )

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

      Applicant respectfully requests consideration of the following Appeal Brief and materials contained herein in response to Final Rejection set forth in the Office Action mailed August 30, 2010. The fee as required under 37 CFR § 41.20 is submitted with this Appeal Brief.

REAL PARTY IN INTEREST

The real party in interest is ALIPHCOM, INC., assignee of record.

RELATED APPEALS AND INTERFERENCES

None.

STATUS OF CLAIMS

Claims 1-3, 6, 8-11, 26, 28-32, 35, 37, 38, 45, 47 and 49 are pending in the application.

Claims 1-3, 6, 8-11, 26, 28-32, 35, 37-38, 45, 47 and 49 are rejected.

Claims 4-5, 7, 12-25, 27, 33-34, 36, 39-44, 46 and 48 are canceled.

STATUS OF AMENDMENTS

No claim is amended subsequent to Final Rejection set forth in the Office Action mailed August 30, 2010.

SUMMARY OF CLAIMED SUBJECT MATTER

Summary

Applicant's present application describes acoustic noise suppression provided in multiple-microphone systems using Voice Activity Detectors (VAD) (page 35, lines 5-6). The application operationally describes a noise removal algorithm that uses a single signal source and a single nose source. This algorithm uses two microphones: a "signal" microphone 1 ("MIC1") and a "noise" microphone 2 ("MIC 2"), but is not so limited. The signal microphone MIC 1 is assumed to capture mostly signal with some noise, while MIC 2 captures mostly noise with some signal (page 7, lines 6-11). The transfer function from the signal source to MIC 2 is denoted by $H_2(z)$, and the transfer function from the noise source to MIC 1 is denoted by $H_1(z)$ (page 7, lines 28-30). As part of the noise suppression system, a noise removal element also receives a signal from a voice activity detection (VAD) element. The VAD uses physiological information to determine when a speaker is speaking including information of human tissue vibration (page 7, lines 18-22).

In conventional two-microphone noise removal systems, the information from MIC 2 is used to attempt to remove noise from MIC 1. However, an (generally unspoken) assumption is that the VAD element is never perfect, and thus the denoising must be performed cautiously, so as not to remove too much of the signal along with the noise. However, if the VAD element is assumed to be perfect such that it is equal to zero when there is no speech being produced by the user, and equal to one when speech is produced, a substantial improvement in the noise removal can be made (page 8, lines 4-10). This latter assumption facilitates a solution to the first and second transfer functions. Output data from MIC 1 and/or MIC 2 may then be used to describe the transfer functions (page 8, line 11 to page 10, line 9).

A first transfer function representative of the acoustic signal is calculated upon determining that voicing information is absent from the acoustic signal for at least one specified period of time. A second transfer function representative of the acoustic signal is calculated upon determining that voicing information is present in the acoustic signal for at least one specified period of time. Noise is removed from the acoustic signal using at least one combination of the first transfer function and the second transfer function, producing denoised acoustic data streams (page 13, lines 18-25).

If the transfer functions $H_1(z)$ and $H_2(z)$ can be described with sufficient accuracy, then

the noise can be completely removed and the original signal recovered. This remains true without respect to the amplitude or spectral characteristics of the noise. The only assumptions made include use of a perfect VAD, sufficiently accurate $H_1(z)$ and $H_2(z)$, and that when one of $H_1(z)$ and $H_2(z)$ are being calculated the other does not change substantially. In practice these assumptions have proven reasonable (page 10, lines 10-15).

Showing of Support of Each Independent Claim:

CLAIM LIMITATION	SUPPORT FOR CLAIM LIMITATION
1. A method for removing noise from acoustic signals, comprising: receiving at least two acoustic signals using at least two acoustic microphones positioned in a plurality of locations;	At least Page 7, lines 8-11, Page 10, lines 17-21, Page 12, lines 3-7, Figures 2-4
receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user;	At least Page 7 lines 18-22, Page 15, lines 14-18, Page 17, line 26 to Page 18, line 2
generating a voice activity detection (VAD) signal using the voice activity signal;	At least Page 17, line 26 to Page 18, line 2, Page 20, lines 9-24
generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function; and	At least Page 8, line 4 to Page 10, line 9, Page 7, lines 28-30
removing acoustic noise from at least one of the acoustic	At least

signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.	Page 8, line 11 to Page 10, line 9, Page 13, lines 16-25
26. A system for removing acoustic noise from the acoustic signals, comprising: a receiver that receives at least two acoustic signals via at least two acoustic microphones positioned in a plurality of locations;	At least Page 7, lines 8-11, Page 10, lines 17-21, Page 12, lines 3-7, Figures 2-4
at least one sensor that receives human tissue vibration information associated with human voicing activity of a user;	At least Page 7 lines 18-22, Page 15, lines 14-18, Page 17, line 26 to Page 18, line 2
a processor coupled among the receiver and the at least one sensor that generates a plurality of transfer functions, wherein the plurality of transfer functions includes a first transfer function representative of a ratio of energy of acoustic signals received using at least two different acoustic microphones of the at least two acoustic microphones, wherein the first transfer function is generated in response to a determination that voicing activity is absent from the acoustic signals for a period of time, wherein the plurality of transfer functions includes a second transfer function representative of the acoustic signals, wherein the second transfer function is generated in response to a determination that voicing activity is present in the acoustic signals for the period of time,	At least Page 8, line 4 to Page 10, line 9, page 7, lines 28-30
wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce the denoised acoustic data stream.	At least Page 8, line 11 to Page 10, line 9, Page 13, lines 16-25

35. A signal processing system coupled among a user and an electronic device, wherein the signal processing system includes a denoising subsystem for removing acoustic noise from acoustic signals, the denoising subsystem comprising a processor coupled among a receiver and at least one sensor, wherein the receiver is coupled to receive the acoustic signals via at least two microphones,	At least Page 7, lines 8-11, Page 10, lines 17-21, Page 12, lines 3-7, Figures 2-4, page 35, lines 5-12
wherein the at least one sensor detects human tissue vibration associated with human voicing activity of a user,	At least Page 7 lines 18-22, Page 15, lines 14-18, Page 17, line 26 to Page 18, line 2
wherein the processor generates a plurality of transfer functions, wherein a first transfer function representative of a ratio of acoustic energy received by the two microphones is generated in response to a determination that voicing activity is absent from the acoustic signals for a specified period of time, wherein a second transfer function representative of the acoustic signals is generated in response to a determination that voicing activity is present in the acoustic signals for a specified period of time,	At least Page 8, line 4 to Page 10, line 9, Page 7, lines 28-30
wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce a denoised acoustic data stream.	At least Page 8, line 11 to Page 10, line 9, Page 13, lines 16-25

GROUNDS OF REJECTION SUBMITTED FOR REVIEW

Whether claims 1-3, 6, 8-11, 26, 28-30, 32, 35, 37, 38 and 41 are unpatentable under 35 U.S.C. 103(a) over Silverberg et al. (United States Patent No. 5,406,622) in view of Holzrichter et al. (United States Patent No. 5,729,694) and Hosoi (United States Patent No. 5,754,665).

Whether claims 31 and 45 are unpatentable under 35 U.S.C. 103(a) over Silverberg et al. (United States Patent No. 5,406,622) as modified by Holzrichter et al. (United States Patent No. 5,729,694) and Hosoi (United States Patent No. 5,754,665) as applied by Examiner to claims 1 and 26, and further in view of Cezanne et al. (United States Patent No. 5,473,701).

Whether claims 47 and 49 are unpatentable under 35 U.S.C. 103(a) over Silverberg et al. (United States Patent No. 5,406,622) as modified by Holzrichter et al. (United States Patent No. 5,729,694) and Hosoi (United States Patent No. 5,754,665) as applied by Examiner to claims 1 and 26, and further in view of Bradley et al. (United States Patent No. 5,463,694).

ARGUMENTS

Rejection under 35 U.S.C. 103(a) over Silverberg et al., United States Patent No. 5,406,622 ("Silverberg") in view of Holzrichter et al., United States Patent No. 5,729,694 ("Holzrichter") and Hosoi, United States Patent No. 5,754,665 ("Hosoi").

Claims 1-3, 6, 8-11, 26, 28-30, 32, 35, 37, 38 and 41

Claims 1-3, 6, 8-11, 26, 28-30, 32, 35, 37, 38 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Silverberg in view of Holzrichter and further in view of Hosoi. As claim 41 is canceled, Examiner's rejection of claim 41 is moot. Applicant respectfully submits that Silverberg, Holzrichter and Hosoi taken either alone or in combination do not teach each and every limitation of claims 1-3, 6, 8-11, 26, 28-30, 32, 35, 37 and 38.

Applicant respectfully submits that Silverberg discloses an outbound noise cancellation circuit that consists of a transmit microphone and one or more noise-collecting reference microphones (column 2, lines 16-19). A first adaptive filter receives the output of a transmit microphone (column 2, lines 26-27). The output of the first adaptive filter is subtractively combined with the output of a reference microphone to provide an enhanced reference signal having little or no speech signal content (column 2, lines 27-33).

A second adaptive filter receives the enhanced reference signal as an input (column 2, lines 34-35). The second adaptive filter produces an output which consists substantially of noise energy only, and the output of the second adaptive filter is a noise cancellation signal (column 2, lines 35-38). The noise cancellation signal is summed with the unprocessed output of the transmit microphone to provide an output signal in which the outbound noise has been removed (column 2, lines 21-25).

Each of the adaptive filters is active or not depending on the presence or absence of speech energy (column 3, lines 10-12). If speech energy is present, the weights of the first adaptive filter are allowed to update, but if speech is absent, the weights of the first adaptive filter are frozen at their last setting (column 3, lines 12-16). Further, if speech energy is absent, the weights of the second adaptive filter are allowed to update, but if speech is present, the weights of the first adaptive filter are frozen at their last setting (column 3, lines 16-20).

Regarding claim 1, the Office Action states (at page 3) that Silverberg does not explicitly teach receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user. Applicant agrees that Silverberg does not teach receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user.

Further regarding claim 1, the Office Action states (at page 3) that Silverberg does not explicitly teach at least two transfer functions that comprise a first transfer function and a second transfer function. Applicant agrees that Silverberg does not teach at least two transfer functions that comprise a first transfer function and a second transfer function.

Further regarding claim 1, the Office Action states (at page 3) that Silverberg does not explicitly teach removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals. Applicant agrees that Silverberg does not teach removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

Further regarding claim 1, Applicant respectfully submits that Silverberg does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent.

Applicant argues that Silverberg teaches nothing about generating transfer functions. In the Examiner's rejection of claim 1 at pages 2-3 of the Office Action, the Examiner does not specifically indicate or particularly point out a section of Silverberg that teaches generating transfer functions. However, it appears (based on Examiner's subsequent rejections of claims 26 and 35 at page 6 and page 8, respectively, of the Office Action) that Examiner intended to argue that the speech filter 12 (Figure 1) and the noise filter 13 (Figure 1) disclose transfer functions. However, Silverberg only discusses filters in terms of general functionality. The disclosure of a filter does not describe its design or technical implementation and does not teach generating transfer functions. In addition, the Examiner at page 3 of the Office Action already stipulates that Silverberg does not teach at least two transfer functions that comprise a first transfer function

and a second transfer function. Accordingly, Silverberg does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent (emphasis added).

For at least the reasons set forth above, Applicant respectfully submits that claim 1 is patentable over Silverberg. Applicant finds no teaching in Holzrichter to overcome the deficiencies of Silverberg.

Applicant respectfully submits that Holzrichter describes the use of EM radiation in conjunction with simultaneously recorded acoustic speech information to enable a complete mathematical coding of acoustic speech. The methods include the forming of a feature vector for each pitch period of voiced speech and the forming of feature vectors for each time frame of unvoiced, as well as for combined voiced and unvoiced speech. The methods include how to deconvolve the speech excitation function from the acoustic speech output to describe the transfer function for each time frame. The formation of feature vectors defining all acoustic speech units over well defined time frames can be used for purposes of speech coding, speech compression, speaker identification, language-of-speech identification, speech recognition, speech synthesis, speech translation, speech telephony, and speech teaching (abstract).

Regarding claim 1, Applicant respectfully submits that Holzrichter does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function, and removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

The Examiner at page 3 of the Office Action argues that element 57 (Figure 5 of Holzrichter) discloses a first transfer function and that element 56 (Figure 5 of Holzrichter) discloses a second transfer function. However, these elements both disclose a Fourier transform which is a measure of the frequency content of a signal. In order to generate a transfer function, two signals (an input and output) are needed. A Fourier transform simply decomposes a signal

into its frequency components and represents a process completely different from, and exclusive of, taking two signals and generating a transfer function.

Interestingly, Examiner appears to ignore the output of the Figure 5 flow diagram which in fact represents a transfer function. Figure 5 shows a system in which knowledge of the vocalized excitation function is used to deconvolve the speech vocal tract transfer function information from measured acoustic speech output for each speech time frame (column 15, lines 29-32). Therefore, Holzrichter does indeed disclose a transfer function. However, Holzrichter only teaches the description of a single transfer function over time. Holzrichter does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function.

As Holzrichter (like Silverberg) fails to disclose at least two transfer functions comprising a first transfer function and a second transfer function, so does Holzrichter (like Silverberg) fail to disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

For at least the reasons set forth above, Applicant respectfully submits that claim 1 is patentable over Holzrichter in view of Silverberg. Applicant finds no teaching in Hosoi to overcome the deficiencies of Holzrichter and Silverberg.

Applicant submits that Hosoi describes a noise canceller comprising analog-to-digital (A/D) converters 11, 12 which convert signals 101, 102 from microphones 2, 3 to digital signals (column 2, lines 53-55). Hosoi describes that the noise canceller includes adder 16 and Finite Impulse Response (FIR) adaptive filter 14 which operate as a noise canceller when microphone 2 is used for speech and microphone 3 is used for noise (column 2, lines 55-58). Hosoi describes that the noise canceller includes adder 15 and FIR adaptive filter 13 which operate as a noise canceller when microphone 2 is used for noise and microphone 3 is used for speech (column 2, lines 58-60).

Regarding the noise cancellation, Hosoi describes that FIR adaptive filter 14 generates an estimated noise signal which is the estimated noise component contained in the voice signal of microphone 2 based on the noise signal from microphone 3. Adder 16 outputs noise-reduced

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output signal 105 by subtracting the estimated noise signal from the voice signal from microphone 2 (column 2, lines 64-67 to column 3, lines 1-3). In the same way, FIR adaptive filter 13 generates an estimated noise signal which is the estimated noise component contained in voice signal of microphone 3 based on the noise signal from microphone 2 (column 3, lines 6-9). Adder 15 outputs voice signal 104 in which noise is reduced by subtracting this estimated noise signal from the voice signal from microphone 3 (column 3, lines 9-12).

Regarding claim 1, Applicant respectfully submits that Hosoi does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function, and removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

Applicant respectfully submits that Hosoi does not teach transfer functions at all. At page 4 of the Office Action the Examiner makes the following puzzling argument (which Examiner then repeats at pages 7 and pages 9-10 in rejecting claims 26 and 35, respectively):

> "Hosoi teaches that the at least two transfer functions comprise a first transfer function (picks up a noise transfer function (not shown) by microphone in fig.3 (2)) and a second transfer function (picks up another speech transfer function (not shown) by microphone in fig. 3 (3)); and removing acoustic noise from at least one of the acoustic signals by applying the first transfer function (noise transfer function) and at least one combination (1) of the first transfer function (noise transfer function) and the second transfer function (speech transfer function) to the acoustic signals" (Office Action, page 4).

It is entirely unclear what Examiner intends to communicate by stating "a first transfer function (picks up a noise transfer function (not shown) by microphone in fig.3 (2))". It appears that Examiner argues that a noise transfer function in Hosoi discloses the first transfer function. However, the Examiner specifically states that the noise transfer function is "not shown" in Figure 3. Hosoi does not elsewhere describe a noise transfer function. Similarly, it appears that Examiner argues that that a speech transfer function in Hosoi discloses a second transfer

function. However, the Examiner specifically states that the speech transfer function is "not shown" in Figure 3. Hosoi does not elsewhere disclose a speech transfer function. Hosoi merely describes the use of two FIR adaptive filters but teaches nothing about such filters' design or technical implementation. Accordingly, Hosoi does not disclose generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function.

As Hosoi (like the combination of Silverberg and Holzrichter) fails to disclose at least two transfer functions comprising a first transfer function and a second transfer function, so does Hosoi (like the combination of Silverberg and Holzrichter) fail to disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

For at least these reasons, Applicant respectfully submits that claim 1 is patentable over Silverberg in view of Holzrichter and further in view of Hosoi.

As claims 2, 3, 6, 8-11, 45, and 47 depend from claim 1 and include further limitations thereon, and since claim 1 is patentable over Silverberg in view of Holzrichter and Hosoi, Applicant submits that claims 2, 3, 6, 8-11, 45, and 47 are patentable over Silverberg in view of Holzrichter and Hosoi.

Applicant submits that claim 26 is patentable over Silverberg in view of Holzrichter and Hosoi for the reasons stated above with reference to claim 1. As claims 28-30, 32 and 49 depend from claim 26 and include further limitations thereon, and since claim 26 is patentable over Silverberg in view of Holzrichter and Hosoi, Applicant submits that claims 28-30, 32 and 49 are patentable over Silverberg in view of Holzrichter and Hosoi.

Applicant submits that claim 35 is patentable over Silverberg in view of Holzrichter and Hosoi for the reasons stated above with reference to claim 1. As claims 37 and 38 depend from claim 35 and include further limitations thereon, and since claim 35 is patentable over Silverberg in view of Holzrichter and Hosoi, Applicant submits that claims 37 and 38 are patentable over Silverberg in view of Holzrichter and Hosoi.

Rejection under 35 U.S.C. 103(a) over Silverberg as modified by Holzrichter and Hosoi as applied by Examiner to claims 1 and 26, and further in view of Cezanne et al., United States Patent No. 5,473,701 ("Cezanne").

Claims 31 and 45

Claims 31 and 45 are rejected under 35 U.S.C. §103(a) as being unpatentable over Silverberg as modified by Holzrichter and Hosoi, and further in view of Cezanne. As described in detail above, the combination of Holzrichter, Silverberg, and Hosoi does not disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals. Applicant also fails to find any teaching in Cezanne of the application of a first transfer function and at least one combination of the first transfer function and the second transfer function. Consequently, the combination of Silverberg, Holzrichter, Hosoi, and Cezanne fails to disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals. For at least this reason, Applicant respectfully submits that claims 31 and 45 are patentable over Silverberg in view of Holzrichter, Hosoi, and Cezanne.

Rejection under 35 U.S.C. 103(a) over Silverberg as modified by Holzrichter and Hosoi as applied by Examiner to claims 1 and 26, and further in view of Bradley et al., United States Patent No. 5,463,694 ("Bradley").

Claims 47 and 49

Claims 47 and 49 are rejected under 35 U.S.C. §103(a) as being unpatentable over Silverberg as modified by Holzrichter and Hosoi, and further in view of Bradley. As described in detail above, the combination of Holzrichter, Silverberg, and Hosoi does not disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and

at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals. Applicant also fails to find any teaching in Bradley of the application of a first transfer function and at least one combination of the first transfer function and the second transfer function. Consequently, the combination of Silverberg, Holzrichter, Hosoi, and Bradley fails to disclose removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals. For at least this reason, Applicant respectfully submits that claims 47 and 49 are patentable over Silverberg in view of Holzrichter, Hosoi, and Bradley.

CLAIMS APPENDIX

The claims stand as follows.

1.   (Previously presented) A method for removing noise from acoustic signals, comprising:

receiving at least two acoustic signals using at least two acoustic microphones positioned in a plurality of locations;

receiving a voice activity signal that includes information on vibration of human tissue associated with human voicing activity of a user;

generating a voice activity detection (VAD) signal using the voice activity signal;

generating at least two transfer functions representative of a ratio of energy of the acoustic signal received using at least two different acoustic microphones of the at least two acoustic microphones when the VAD indicates that user voicing activity is absent, wherein the at least two transfer functions comprise a first transfer function and a second transfer function; and

removing acoustic noise from at least one of the acoustic signals by applying the first transfer function and at least one combination of the first transfer function and the second transfer function to the acoustic signals and generating denoised acoustic signals.

2.   (Previously presented) The method of claim 1, wherein removing noise further comprises:

generating one transfer function of the at least two transfer functions to be representative of a ratio of energy of the acoustic signal received when the VAD indicates that user voice activity is present; and

removing noise from the acoustic signals using at least one combination of the at least two transfer functions to generate the denoised acoustic signals.

3.   (Previously presented) The method of claim 1, wherein the acoustic signals include at least one reflection of at least one associated noise source signal and at least one reflection of at least one acoustic source signal.

Claims 4 and 5 (Canceled).

6.   (Previously presented) The method of claim 1, wherein generating the at least two transfer functions comprises recalculating the at least two transfer functions during at least one prespecified interval.

Claim 7 (Canceled).

8.   (Previously presented) The method of claim 1, wherein generating the at least two transfer functions comprises use of at least one technique selected from a group consisting of adaptive techniques and recursive techniques.

9.   (Previously presented) The method of claim 1, wherein information on the vibration of human tissue is provided by a sensor in contact with the skin.

10.   (Previously presented) The method of claim 1, wherein information on the vibration of human tissue is provided via at least one sensor selected from among at least one of an accelerometer, a skin surface microphone in physical contact with skin of a user, a human tissue vibration detector, a radio frequency (RF) vibration detector, and a laser vibration detector.

11.   (Previously presented) The method of claim 1, wherein the human tissue is at least one of on a surface of a head, near the surface of the head, on a surface of a neck, near the surface of the neck, on a surface of a chest, and near the surface of the chest.

Claim 12-25 (Canceled).

26.   (Previously presented) A system for removing acoustic noise from the acoustic signals, comprising:

    a receiver that receives at least two acoustic signals via at least two acoustic microphones positioned in a plurality of locations;

at least one sensor that receives human tissue vibration information associated with human voicing activity of a user;

a processor coupled among the receiver and the at least one sensor that generates a plurality of transfer functions, wherein the plurality of transfer functions includes a first transfer function representative of a ratio of energy of acoustic signals received using at least two different acoustic microphones of the at least two acoustic microphones, wherein the first transfer function is generated in response to a determination that voicing activity is absent from the acoustic signals for a period of time, wherein the plurality of transfer functions includes a second transfer function representative of the acoustic signals, wherein the second transfer function is generated in response to a determination that voicing activity is present in the acoustic signals for the period of time, wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce the denoised acoustic data stream.

Claim 27 (Canceled).

28.   (Previously presented) The system of claim 26, wherein the sensor includes a mechanical sensor in contact with the skin.

29.   (Previously presented) The system of claim 26, wherein the sensor includes at least one of an accelerometer, a skin surface microphone in physical contact with skin of a user, a human tissue vibration detector, a radio frequency (RF) vibration detector, and a laser vibration detector.

30.   (Previously presented) The system of claim 26, wherein the human tissue is at least one of on a surface of a head, near the surface of the head, on a surface of a neck, near the surface of the neck, on a surface of a chest, and near the surface of the chest.

31.   (Previously presented) The system of claim 26, further comprising:

dividing acoustic data of the acoustic signals into a plurality of subbands;

generating a transfer function representative of the ratio of acoustic energies received in each microphone in each subband;

removing acoustic noise from each of the plurality of subbands using a transfer function, wherein a plurality of denoised acoustic data streams are generated; and

combining the plurality of denoised acoustic data streams to generate the denoised acoustic data stream.

32. (Previously presented) The system of claim 26, wherein the receiver includes a plurality of independently located microphones.

Claims 33 and 34 (Canceled).

35. (Previously presented) A signal processing system coupled among a user and an electronic device, wherein the signal processing system includes a denoising subsystem for removing acoustic noise from acoustic signals, the denoising subsystem comprising a processor coupled among a receiver and at least one sensor, wherein the receiver is coupled to receive the acoustic signals via at least two microphones, wherein the at least one sensor detects human tissue vibration associated with human voicing activity of a user, wherein the processor generates a plurality of transfer functions, wherein a first transfer function representative of a ratio of acoustic energy received by the two microphones is generated in response to a determination that voicing activity is absent from the acoustic signals for a specified period of time, wherein a second transfer function representative of the acoustic signals is generated in response to a determination that voicing activity is present in the acoustic signals for a specified period of time, wherein acoustic noise is removed from the acoustic signals using the first transfer function and at least one combination of the first transfer function and the second transfer function to produce a denoised acoustic data stream.

Claim 36 (Canceled).

37. (Previously presented) The system of claim 35, wherein the at least one electronic device includes at least one of cellular telephones, personal digital assistants, portable communication devices, computers, video cameras, digital cameras, and telematics systems.

38.   (Previously presented) The system of claim 35, wherein the human tissue is at least one of on a surface of a head, near the surface of the head, on a surface of a neck, near the surface of the neck, on a surface of a chest, and near the surface of the chest.

Claim 39-44 (Canceled).

45.   (Previously presented) The method of claim 1, further comprising:

dividing acoustic data of the acoustic signals into a plurality of subbands;

generating a subband transfer function representative of the ratio of acoustic energies received in each microphone in each subband;

removing acoustic noise from each of the plurality of subbands using the subband transfer function, wherein a plurality of denoised acoustic subband signals are generated; and

combining the plurality of denoised acoustic subband signals to generate the denoised acoustic signal.

Claim 46 (Canceled).

47.   (Previously presented)   The method of claim 1, wherein the at least two acoustic microphones comprise a first directional acoustic microphone and a second directional acoustic microphone, wherein the first directional acoustic microphone and the second directional acoustic microphone selectively attenuate the acoustic signals based on the direction of arrival.

Claim 48 (Canceled).

49.   (Previously presented)   The system of claim 26, wherein the at least two acoustic microphones comprise a first directional acoustic microphone and a second directional acoustic microphone, wherein the first directional acoustic microphone and the second directional acoustic microphone selectively attenuate the acoustic signals based on the direction of arrival.

EVIDENCE APPENDIX
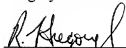
None.

RELATED PROCEEDINGS APPENDIX

None.

Conclusion:

Applicant respectfully submits that the claims of the above-captioned patent application are in condition for allowance, and respectfully requests that the Board of Patent Appeals and Interferences allows the claims of the above-captioned patent application to issue in a US patent.

Respectfully submitted,
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